

# ZERO-EMISSION TRUCK AND BUS MARKET UPDATE

JUNE 2023



## ABOUT

The Zero-Emission Truck and Bus Market Update is a semi-annual report that provides insight into the fast-developing zero-emission medium- and heavy-duty vehicle (ZE-MHDV) market. This report is intended to assist stakeholders and decisionmakers in implementing technology-driven strategies by highlighting salient trends for ZE-MHDVs. It presents a series of charts and figures to aid in deepening the understanding of global ZE-MHDV model availability, vehicle range, and original equipment manufacturer (OEM) status. This analysis also features key takeaways that can help guide future ZE-MHDV deployments with a high-level overview of trends observed by region, vehicle segment, and technology. Additionally, this report includes global ZE-MHDV sales and stock by region and segment, which further contributes to a wholistic view of the market by complementing supply with demand-side trends and suggesting market acceptance. This report uses data drawn from CALSTART's Zero-Emission Technology Inventory (ZETI), a regularly updated inventory of worldwide commercially available offerings of ZE-MHDVs (CALSTART, 2022a).

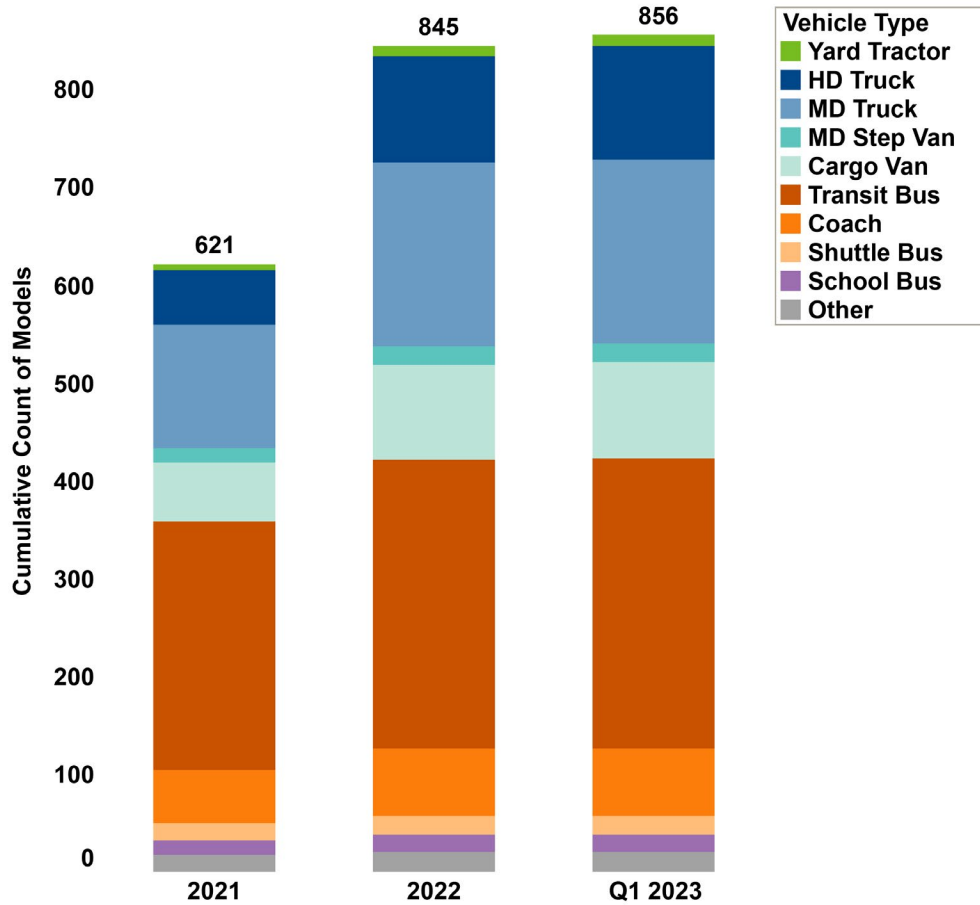
## KEY TAKEAWAYS

- Since October 2022, 59 new ZE-MHDV models have been added to ZETI. This total comprises 15 cargo vans, 10 medium-duty (MD) trucks, seven heavy-duty (HD) trucks, 22 transit buses, four coaches, and one school bus. Mexico and New Zealand are also now included as part of the key regions/countries tracked in ZETI.
- ZE-MHDV model availability has grown nearly 38% from 2021 through the first quarter (Q1) of 2023 (from 621 models to 856 models), and transit buses still make up the largest share among zero-emission vehicle types.
- There are 147 individual OEMs operating across the United States (U.S.) & Canada, Europe, China, Mexico, India, South America, and Oceania.<sup>1</sup> The U.S. & Canada (62 OEMs) have the greatest number of OEMs in operation, but China (40 OEMs) has the greatest number of models available and has experienced the highest growth in new models.
- The median range of zero-emission HD trucks is 157 miles (mi) or 253 kilometers (km). This range meets the duty-cycle demands of most local and regional hauling, while the highest range of 500 mi or 805 km indicates promising capabilities for longer haul.
- Roughly half of zero-emission buses available as of Q1 2023 have a manufacturer-reported range between 113 mi and 292 mi or between 182 km and 470 km. A median range of 205 mi or 330 km is considered sufficient for most urban transit operations.
- The average range of almost all zero-emission vehicles has progressively increased over the past three years. The annual average ranges for the zero-emission truck and bus segments have grown by 11% and 13%, respectively, from 2020 to 2023.

<sup>1</sup> Oceania includes Australia and New Zealand.

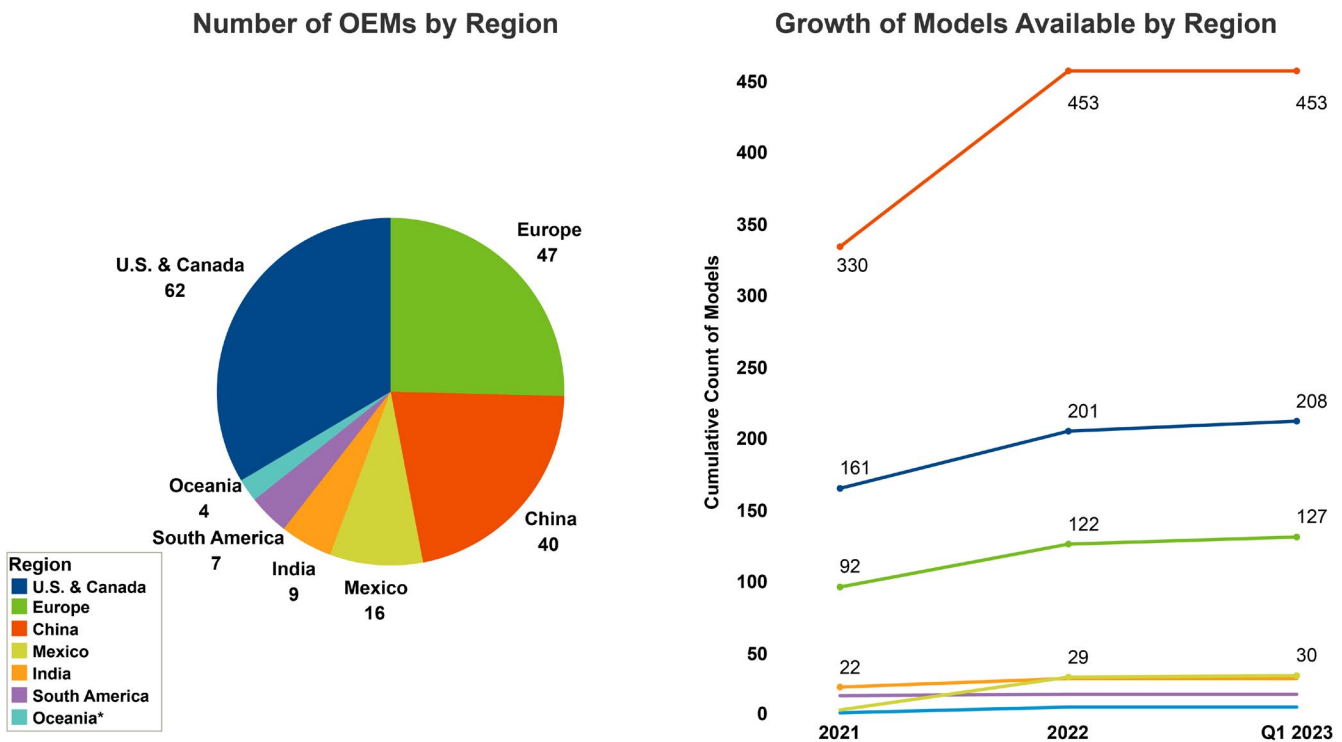
# ZE-MHDV MODEL AVAILABILITY AND OEM PRESENCE GROWING GLOBALLY

Figure 1. Global ZE-MHDV Model Availability (2021 to Q1 2023)



- ZE-MHDV model availability has grown nearly 38% from 2021 through Q1 2023 (from 621 models to 856 models).
- Transit buses still make up the largest share among zero-emission vehicle types, while the number of HD trucks doubled from 2021 to Q1 2023.
- Model availability from 2021 to Q1 2023 grew the most for HD trucks (107%), followed by cargo vans (67.8%) and MD trucks (50.4%).
- Currently, more OEMs are manufacturing zero-emission transit buses, but the number of OEMs manufacturing the various truck types has also shown sharp growth through Q1 2023.
- The zero-emission MD and HD truck markets have experienced a drastic increase from 2021 to Q1 2023, with approximately 50 OEMs offering new ZE-MHDV models of both truck types.
- There are now 42 OEMs offering zero-emission cargo vans, showing steady growth since 2021.

**Figure 2.** Global ZE-MHDV OEM and Model Availability by Region (2021 to Q1 2023)

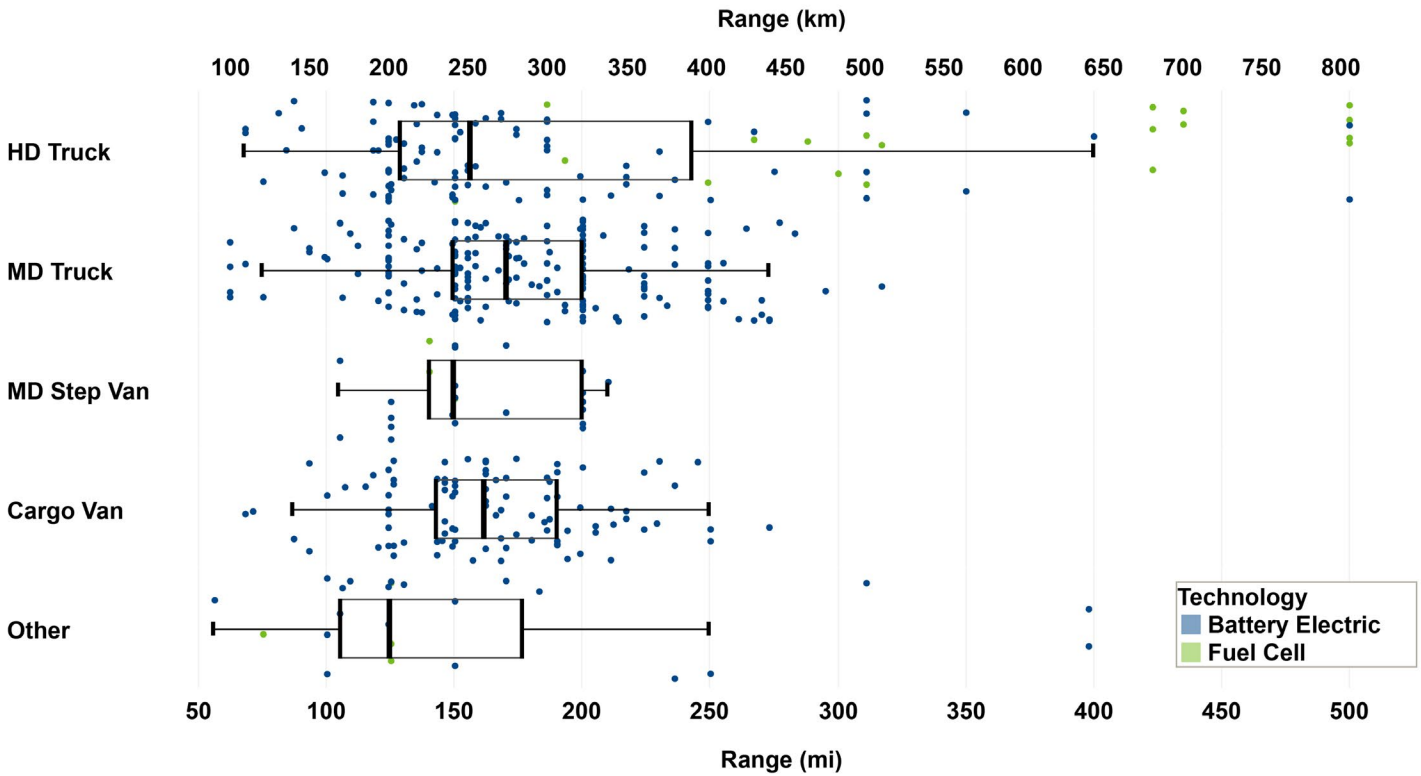


\*Note: Oceania includes only Australia and New Zealand currently.

- There are 147 individual OEMs operating in the seven main regions/countries tracked in ZETI, including new data from Mexico and New Zealand. Many OEMs operate in multiple regions, which affects the totals in Figure 2.
- Mexico is one of the key regions that has recently been added to ZETI—16 OEMs are logged as of Q1 2023, while only five were recorded for the country in 2021. The country started with six models in 2021 and will end Q1 2023 with 30 models available.
- China experienced a 66% growth in OEMs between 2021 and Q1 2023. It represents the vast majority of the ZE-MHDV market growth, going from 330 models in 2021 to 453 models in Q1 2023—a rise of 37% driven by the zero-emission transit bus segment, with 40 OEMs operating in the country.
- The U.S. & Canada had a 44% growth in OEMs from 2021 to Q1 2023 (from 43 to 62). The region showed ZE-MHDV model growth of 29% (from 161 to 208) in the same period. This trend is driven by a strong MD truck market.
- Europe showed a 27% growth in OEMs (from 37 to 47) during this period. It experienced an intense ZE-MHDV market growth from 2021 to 2022 of 33%, followed by a steady increase after 2022.

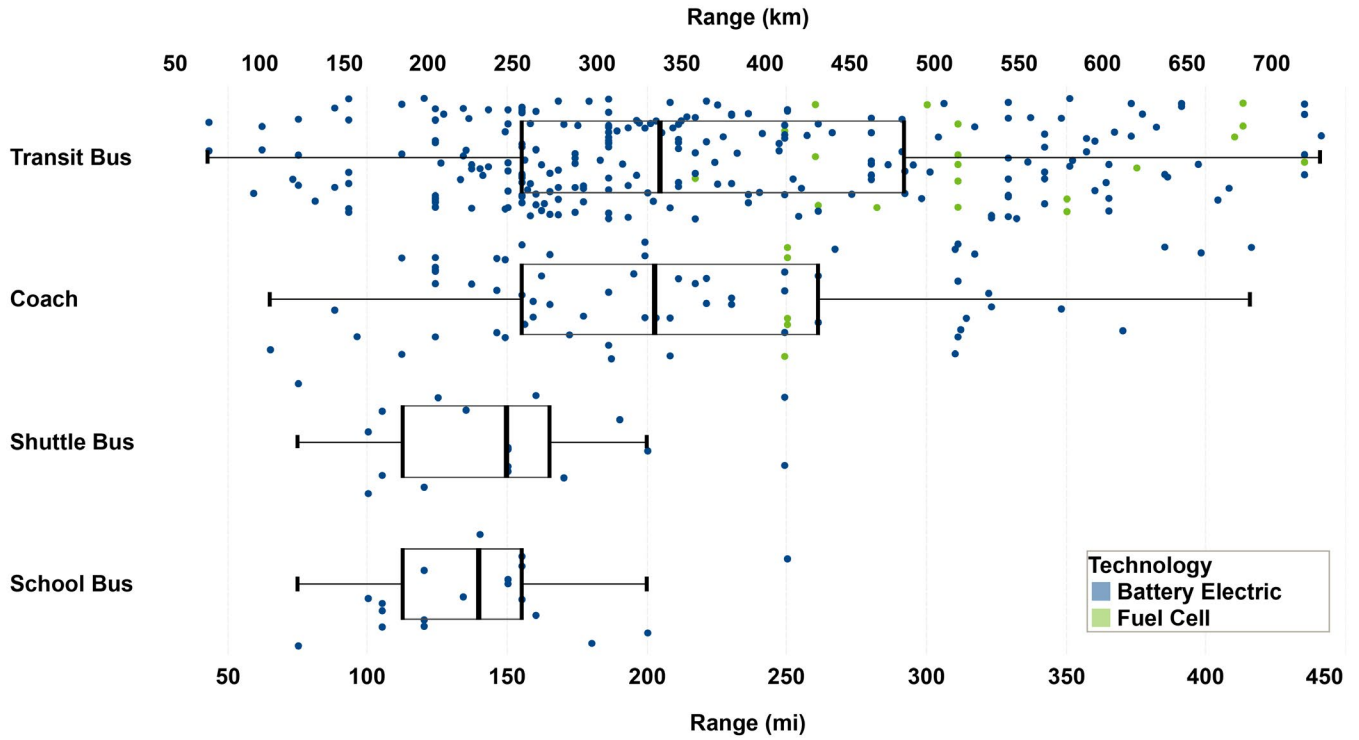
# GROWING ZE-MHDV RANGE INDICATES OPERATIONAL VIABILITY ACROSS SEGMENTS

**Figure 3.** Distribution of Global Zero-Emission Truck Range by Vehicle Segment



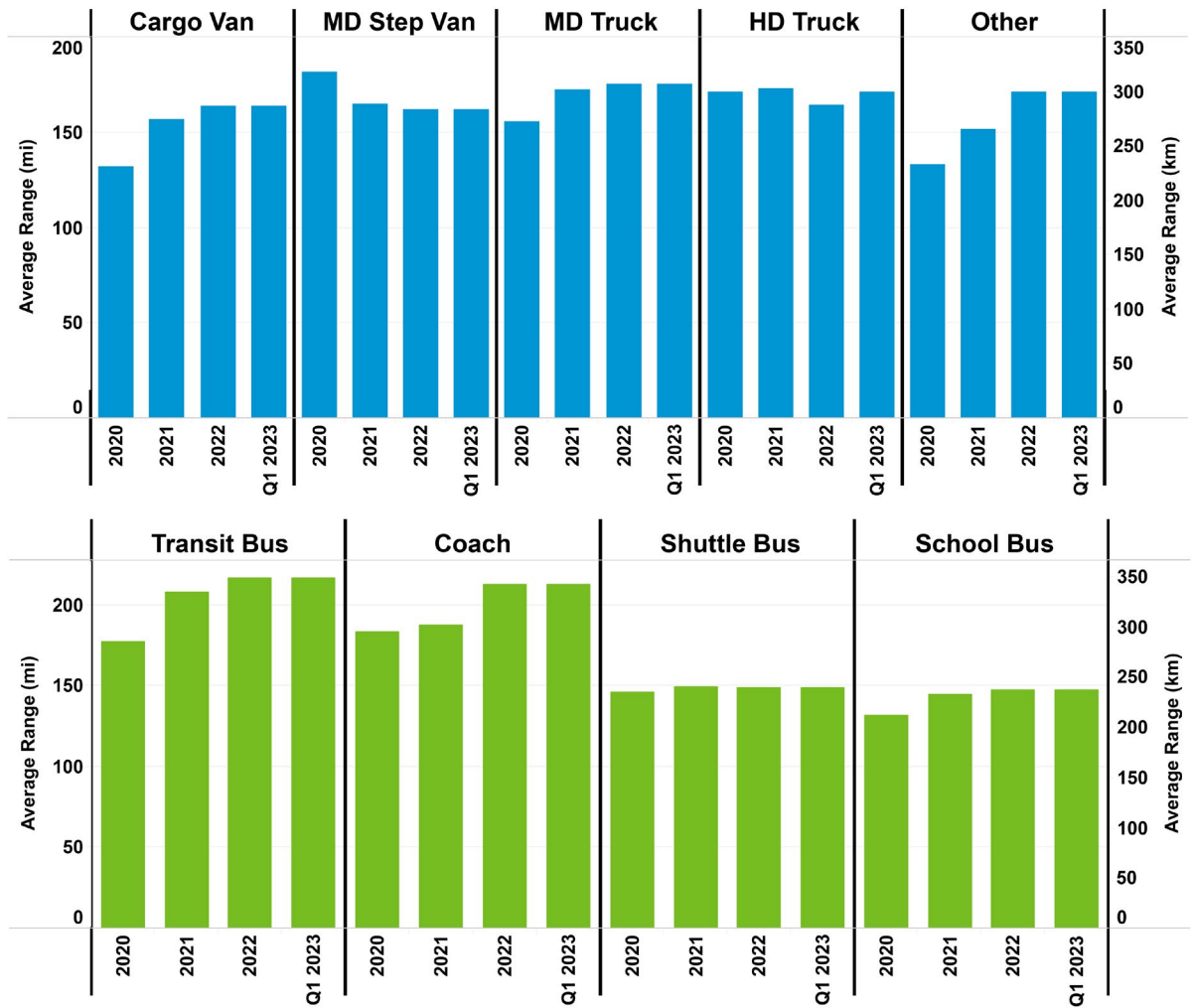
- The median range of zero-emission HD trucks is 157 mi or 253 km, with the lowest range of 68 mi or 110 km to the highest range of 500 mi or 805 km.
- Zero-emission MD trucks, MD step vans, and cargo vans on the market as of Q1 2023 have median ranges of 170.5 mi or 274 km, 150 mi or 241 km, and 162 mi or 261 km, respectively, according to manufacturer data.
- According to data from the U.S. Department of Transportation (DOT), approximately two-thirds of trucks travel no more than 50 miles from their base each day, and more than 80% travel no more than 100 miles (U.S. DOT, 2022). The ranges reported by OEMs in ZETI are higher than distances trucks travel every day, implying electric trucks can meet duty-cycle requirements in most cases if fleets plan their routes and charging properly.

**Figure 4.** Distribution of Global Zero-Emission Bus Range by Vehicle Segment



- Roughly half of zero-emission buses available as of Q1 2023 have a manufacturer-reported range between 113 mi or 182 km and 292 mi or 470 km, sufficient for most urban transit operations.
- Zero-emission transit buses on the market as of Q1 2023 have a median range of 205 mi or 330 km, with several manufacturers reporting ranges greater than 292 mi or 470 km.
- According to manufacturer data, zero-emission school buses and shuttle buses are reported to have a median range of 140 mi or 225 km and 150 mi or 241 km, respectively.

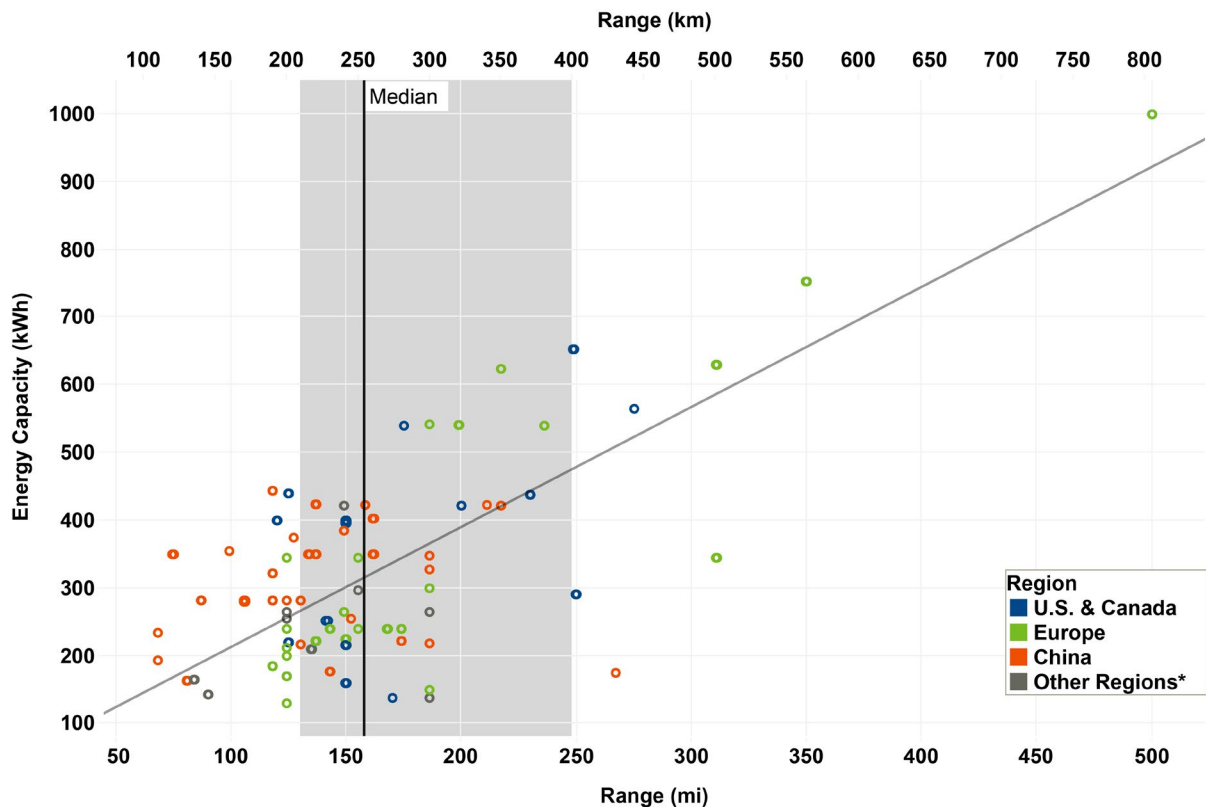
**Figure 5.** Progression of Cumulative Average (Mean) Annual Zero-Emission Truck and Bus Ranges (2020 to Q1 2023)



- The average distance traveled by zero-emission cargo vans has increased from 132 mi or 212 km in 2020 to 164 mi or 264 km in Q1 2023.
- The estimated range of zero-emission MD trucks has also increased slightly by 19.31 mi or 31 km (from 156 mi or 251 km in 2020 to 175 mi or 282 km in Q1 2023).
- The number of miles traveled by other zero-emission vehicles—many being refuse trucks—has increased slightly from 133 mi or 214 km in 2020 to 171 mi or 276 km in Q1 2023.
- Fewer zero-emission MD step vans were launched from 2020 to Q1 2023, which may explain the decrease in average range from 182 mi or 292 km to 162 mi or 260 km.
- The average range of zero-emission HD trucks varies during the same period and ends with 173 mi or 278 km in Q1 2023.
- Zero-emission transit buses show a strong rise from 177 mi or 286 km in 2020 to 217 mi or 349 km in Q1 2023.

- The estimated range of the zero-emission coach segment has also increased by 29.41 mi or 47.33 km (from 183 mi or 295 km in 2020 to 213 mi or 342 km in Q1 2023).
- The ranges of zero-emission shuttle buses (150 mi or 240 km in Q1 2023) and school buses (148 mi or 238 km in Q1 2023) show steady growth.
- Zero-emission cargo vans and MD step vans usually operate less than 100 miles on local duty cycles, while MD trucks and HD trucks operate up to 300 miles to meet long-haul needs (Zhang, 2021). Electric trucks in ZETI fulfill these mileage requirements, indicating most electric trucks can be good replacements for diesel trucks.

**Figure 6. HD Truck Range and Energy Capacity in Key Regions**

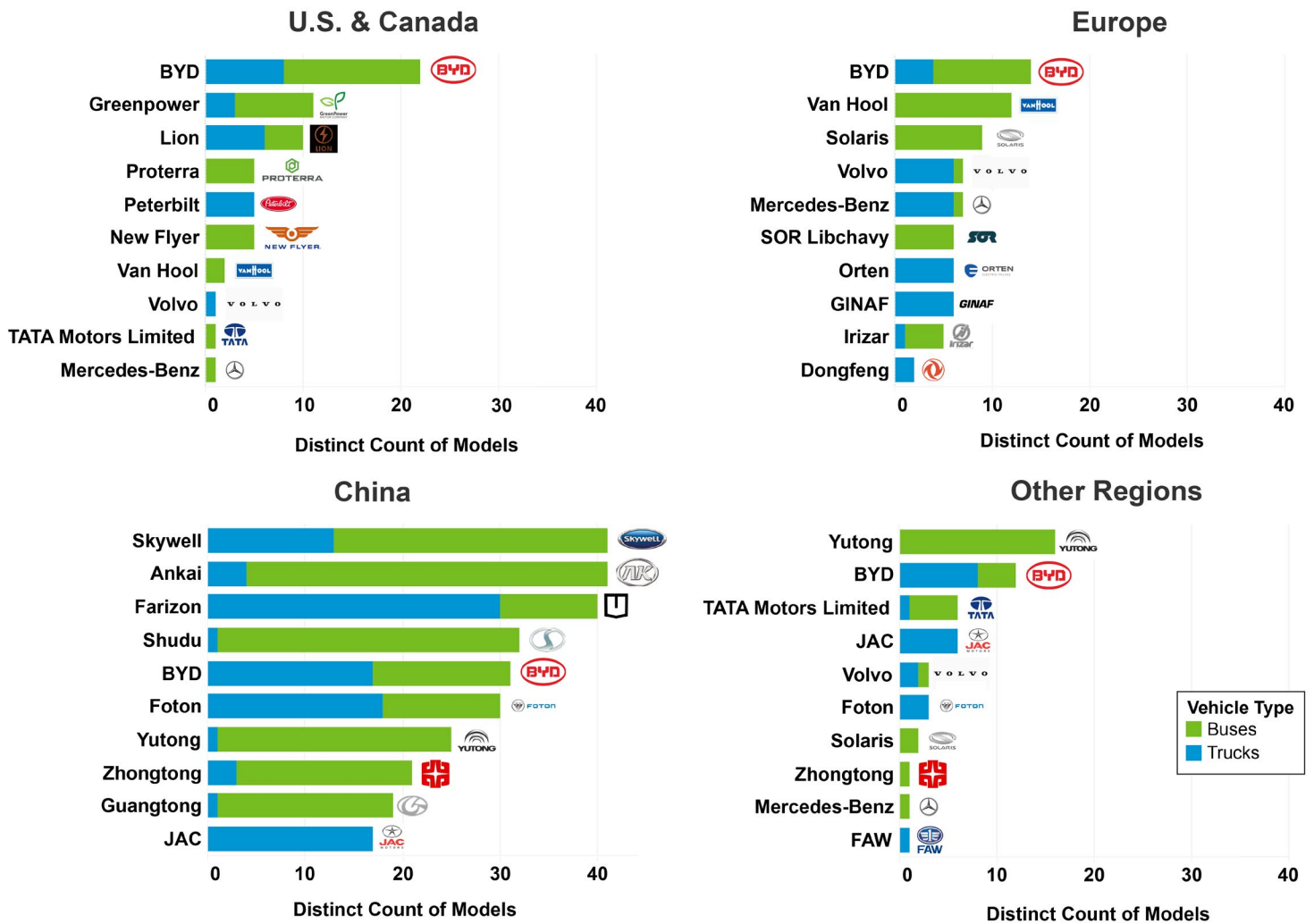


\*Note: Other Regions includes India, Mexico, South America, and Oceania (Australia and New Zealand).

- Figure 6 above shows the relationship between energy capacity (i.e., battery size) and range. In the U.S. & Canada, zero-emission HD trucks have a median range of 173 mi or 278 km, with battery sizes ranging from 210 kilowatt-hours (kWh) to 1,000 kWh.
- The manufacturer data shows statistical significance (i.e., p-value <0.0001) between energy capacity and range—meaning the larger the battery, the farther a HD truck can run.
- Based on the ZETI database, the payload of zero-emission HD trucks varies from 12,390 pounds (lbs.) or 5,620 kilograms (kg) to 82,000 lbs. or 37,195 kg. The average payload of zero-emission HD trucks in the U.S. & Canada is 52,536 lbs. or 23,830 kg. Europe and China have an average payload of 36,581 lbs. or 16,593 kg and 42,403 lbs. or 19,234 kg, respectively.

# REGIONAL OEM PRESENCE AND GLOBAL ZE-MHDV SALES HIGHLIGHT MARKET PREFERENCES AND STEADY GROWTH

**Figure 7.** Top 10 OEMs in Key Regions by Models Available



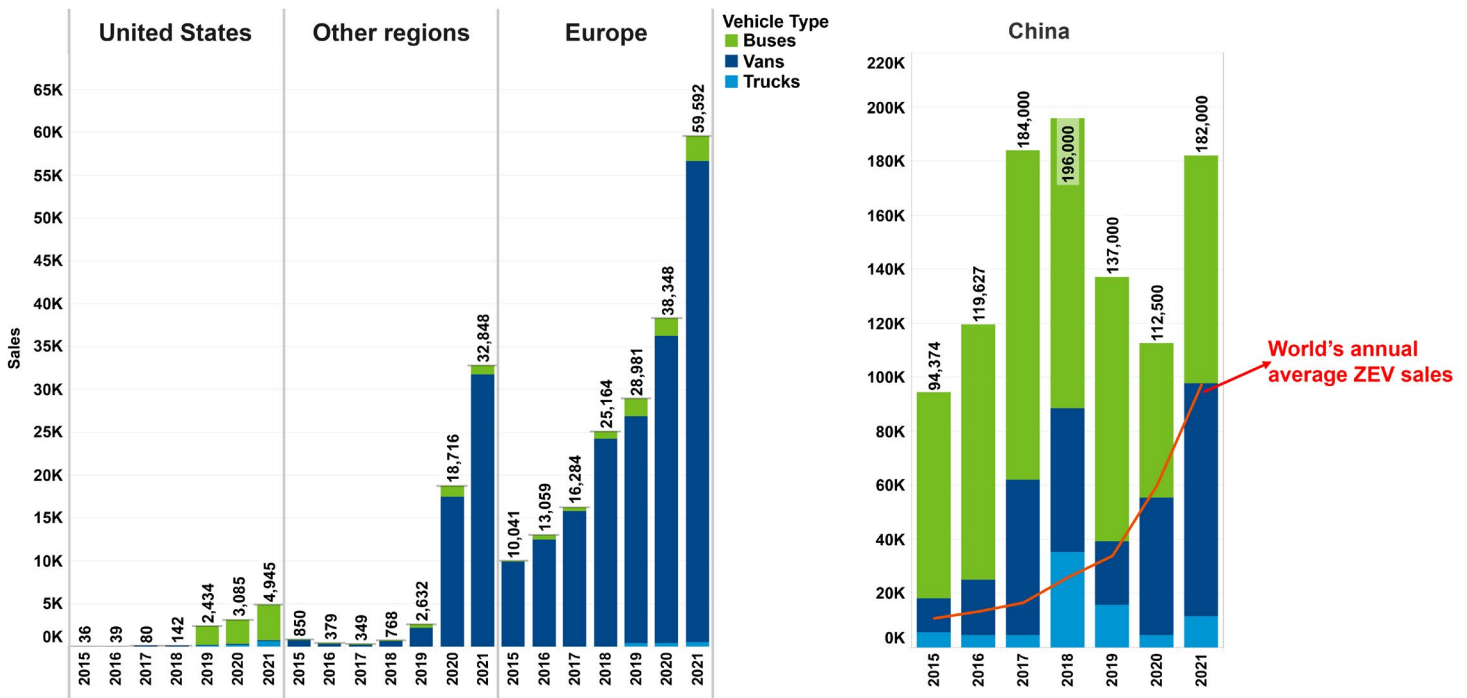
\*Note: Charts exclude upfitters such as SEA Electric and Motive Power System. Other Regions includes India, Mexico, Oceania (Australia and New Zealand), and South America. Buses include zero-emission transit bus, coach, school bus, and shuttle bus. Trucks include zero-emission cargo van, MD step van, MD truck, HD truck, yard tractor, and other (refuse truck).

- BYD, a Chinese domestic OEM, is one of the top-tier brands in the above regions. Swedish multinational manufacturing corporation Volvo shows a strong manufacturing presence in the U.S. & Canada, Europe, and Other Regions with deployed trucks and buses.



- In the U.S. & Canada, BYD provides 22 models, while Greenpower—a Canadian electric bus manufacturer with a variety of zero-emission transit buses, school buses, cargo vans, and MD trucks—has 11 models in operation. Zero-emission buses are the preferred segment for the top 10 OEMs in this region.
- Skywell and Ankai both have 41 models available in China. Zero-emission transit buses are taking up the largest market share in the country.

**Figure 8.** The Volume of ZE-MHDV Sales by Vehicle Type in the U.S., Europe, China, and Other Regions (2015 to 2021)<sup>2</sup>



\*Note: No update for ZE-MHDV sales in Q1 2023.

- Total ZE-MHDV sales rose constantly from 2015 to 2021 in all the key regions above (except China), led by the zero-emission bus segment. While the zero-emission bus segment dominates in the U.S. and China, Europe and other regions are mainly focused on deploying vans.
- Total ZE-MHDV sales varied from year-to-year in China from 2015 to 2021 and were consistently led by the zero-emission bus segment, which is driven by substantial subsidies.
- ZE-MHDV sales in the U.S. had an average year-over-year growth rate of 44% from 2019 to 2021.

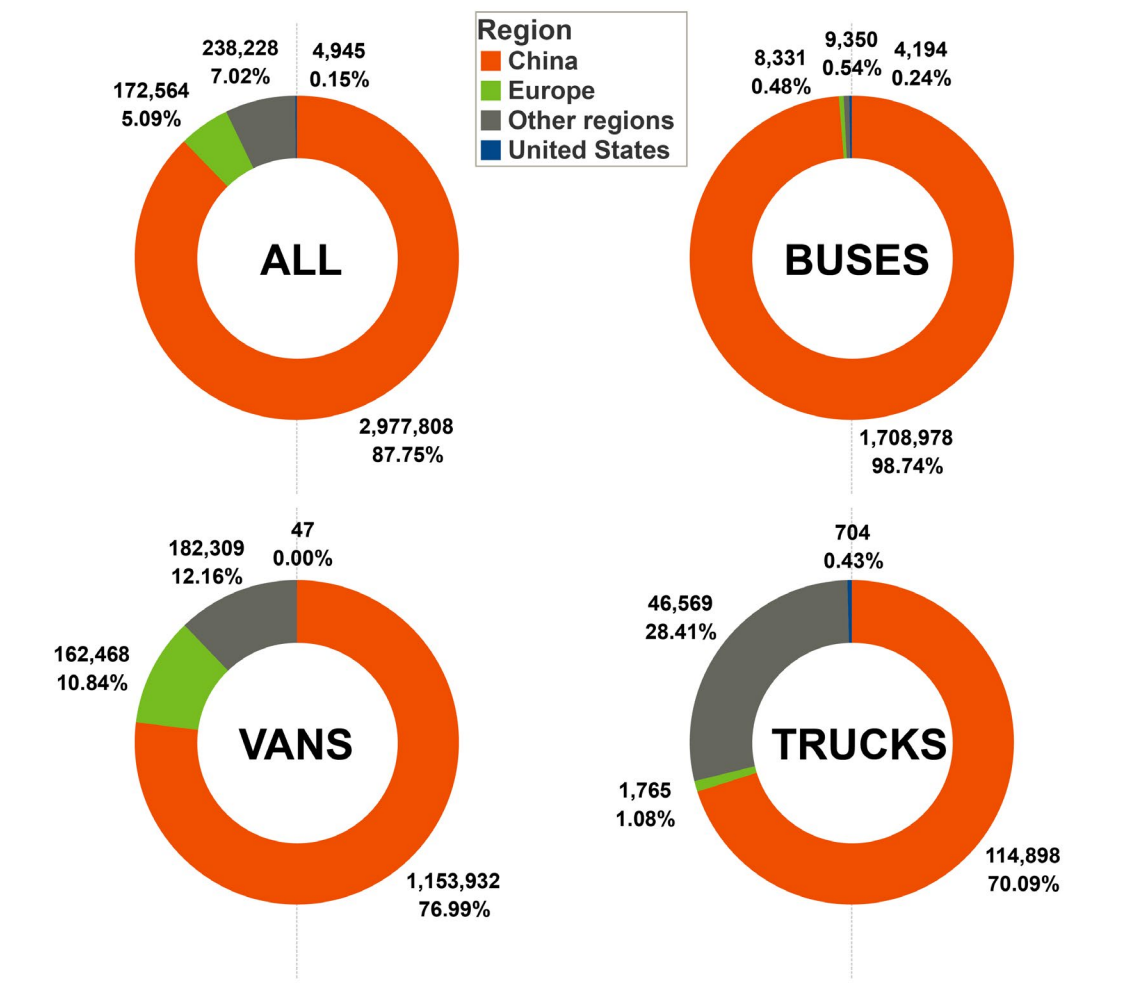
2 The U.S.: ZE-MHDV sales in bus collection began in 2019.

Europe: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, and other Europe.

Other regions: Canada, Chile, India, Japan, Korea, New Zealand, Uruguay, and rest of the world.

- ZE-MHDV sales in the other regions had an average year-over-year growth rate of 343% from 2019 to 2021.
- During 2019 to 2021, Europe's average year-over-year growth rate was 44%.
- Globally, zero-emission truck sales have grown 124.11% from 2015 to 2021.

**Figure 9.** Global ZE-MHDV Stocks and Shares by the U.S., Other Regions, Europe, and China in 2021



*Note: No update for ZE-MHDV sales in Q1 2023.*

- Figure 9 above depicts the ZE-MHDV stock (i.e., total cumulative ZE-MHDVs registered) in 2021 and shares of stock by region. It also captures the breakdown of vehicle category across buses, vans, and trucks.
- The total ZE-MHDV stock for each region in 2021 reflects the approach established by CALSTART's Beachhead Strategy. Buses and vans are leading deployments, with truck volumes growing and technology and operational capacity continuing to improve (CALSTART, 2022b).

## OUTLOOK FOR FUTURE RESEARCH

ZETI and ZETI Data Explorer are constantly updated with the most recent vehicle information as new models come to market. This report will be updated semi-annually with new data and insights.

For more information, visit the tools on the Global Commercial Vehicle Drive to Zero Program's website: <https://globaldrivetozero.org>. We welcome any questions or concerns and invite collaboration in the pursuit of maintaining the most accurate and up-to-date inventory possible.

## DATA NOTE

Vehicle and model specific data in this report is drawn primarily from the Global Commercial Vehicle Drive to Zero Program's Zero-Emission Technology Inventory v8.2. (ZETI), which uses manufacturer-reported information to provide insights on the various technologies available or coming to market.

Zero-emission vehicle sales and stock data are drawn from two sources: primarily the IEA's Global EV Data Explorer (IEA, 2022), which covers the majority of country-specific data. However, there are several gaps that were complemented by sales data drawn from EV Volumes. Country-specific data that was sourced from EV Volumes include Austria, Chile, Luxembourg, Turkey, and Uruguay. All other country-specific data is from the IEA. Data on U.S. sales volumes was drawn from CALSTART's Zeroing in on ZETs/ZEBs reports (CALSTART, 2022c) (CALSTART, 2023).



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